06617

CONDUCTOR RESISTANCE FAULTMETER/LOCATOR

Test & Measurement Systems/3M

3M

Operating Instructions

Dynatel®

710A

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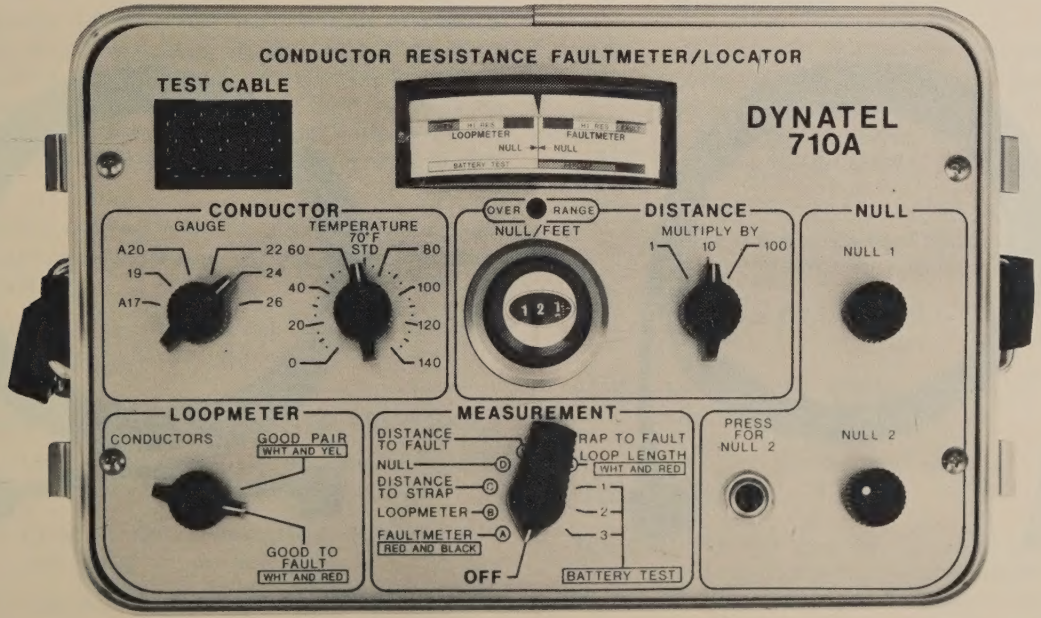
CONDUCTOR RESISTANCE FAULTMETER/LOCATOR
TEST CABLE
LOOPMETER
FAULTMETER
NULL
NULL
BATTERY TEST
DYNATEL
710A
CONDUCTOR
GAUGE
TEMPERATURE
70° F
STD
A20
19
A17
22
24
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OVER
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NULL/FEET
DISTANCE
MULTIPLY BY
1
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CONDUCTORS
GOOD PAIR
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GOOD TO
FAULT
WHT AND RED
MEASUREMENT
DISTANCE
TO FAULT
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DISTANCE
TO STRAP
LOOPMETER
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RED AND BLACK
OFF
STRAP TO FAULT
LOOP LENGTH
WHT AND RED
1
2
3
BATTERY TEST
PRESS
FOR
NULL 2
NULL 2

Thermo-Calibrator

33′ Extension Cable

SECTION I OPERATION

1-1. INTRODUCTION

The Dynatel 710A locates high and low resistance faults in telephone cable. Shorts, crosses, grounds and battery crosses can all be accurately located and distance measurements displayed directly in feet. Both the distance-to-fault and strap-to-fault distance can be measured from one end of the cable.

A built-in FAULTMETER and LOOPMETER provide a nontechnical means of testing the conductors and hook-up.

In many instances the Dynatel 710A may be used to locate faults without requiring a good pair.

1-2. ABBREVIATED FAULT LOCATING PROCEDURE

STEP 1. Use the FAULTMETER to locate the faulted conductors and to test the good pair.

STEP 2. Connect the 710A test-set to the cable and install the far-end-strap.

STEP 3. Use the LOOPMETER to test the conductor loop and strap connections.

STEP 4. Set the conductor GAUGE and conductor TEMPERATURE controls.

STEP 5. Measure the DISTANCE TO STRAP and compare with an estimated length as a check on conductor gauge and cable routing. An optional series fault (partial open) test may be performed in this step.

STEP 6. Adjust the NULL 1 control for a null, then press the pushbutton while adjusting the NULL 2 control for a null.

STEP 7. Measure the DISTANCE TO FAULT and record.

STEP 8. Measure the STRAP TO FAULT distance and record.

1-3. FAULTMETER

The FAULTMETER provides a quick method for locating and analyzing faulted conductors. Voltage does not affect the meter indication as it would using a voltmeter or ohmmeter. Since the meter

is clearly labeled GOOD, HIGH RESISTANCE and FAULT, interpretation is unnecessary.

A fault from 0 ohms to 1.5 megohms is indicated as a FAULT. A light fault from 1.5 to 15 megohms is indicated as HIGH RESISTANCE while a resistance from 15 to 200 megohms is indicated as GOOD.

1-4. FAULTMETER OPERATION

Set the measurement switch to FAULTMETER and connect the black test clip to ground. Use the red test clip to probe the various conductors.

Check as many conductors as are available in order to obtain a clear understanding of the trouble in the cable. NEVER dig a hole on the basis of a single trouble reading if additional pairs are available for test.

A written notation should be made for all of the conductors tested. List the pair number and the condition of the tip and the ring conductors.

1-5. FAULT IDENTIFICATION METHOD

Connect the black test clip to ground and the red test clip to the tip conductor of a pair and note FAULTMETER indication. Next, move the red test clip to the ring conductor and note FAULTMETER indication. So far this procedure will have detected any tip or ring grounds or battery crosses.

With the red test clip still connected to the ring, touch the tip conductor to ground and note FAULTMETER indication. The FAULTMETER will indicate a tip-ring short as a result of conduction through the fault to ground. Crosses can be located using the same method.

Due to the high sensitivity of the FAULTMETER, tinsel transfer clips or any material with less than 1 megohm resistance may be used to ground the conductor. The black test clip may be connected directly to the conductor to be tested, but the grounding method is usually more convenient and provides more safety.

The current from the FAULTMETER is limited to approximately 50 microamperes and will have minimum "drying effect" on conductor faults.

1-6. INSTRUMENT HOOK-UP

There are two basic hook-ups; a single pair hook-up and a separate good pair hook-up. The separate good pair hook-up allows a series fault test to be performed and in some cases provides a slight improvement in accuracy when the fault is near the far-end-strap.

When locating grounds or battery crosses with the single pair hook-up, the quality of the good conductor needs to be better than when locating shorts. When the faulted conductor reading as tested, borders on the HIGH RESISTANCE designation on the faultmeter scale, good conductor should indicate well into the green GOOD range on the faultmeter.

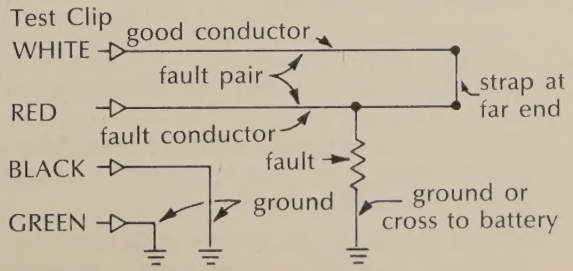
The **red clip is always connected to the faulted conductor** and the black clip to the other side of the fault. For grounds and battery crosses, the black clip should be connected to ground. When testing ungrounded shorts or crosses between known conductors, the black clip will be connected to the crossed or shorted conductor.

Note: Once the instrument hook-up is complete, returning the MEASUREMENT switch to FAULTMETER should cause the faultmeter to register a faulted condition.

The yellow test clip may be left disconnected if only one good conductor is available. The green test clip is the instrument protective ground and should always be connected to earth ground.

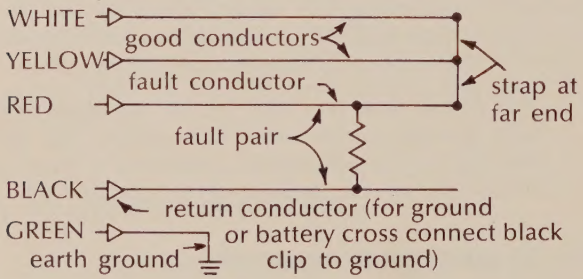
A. SINGLE PAIR HOOK-UP:

Using only the pair in trouble.



B. SEPARATE GOOD PAIR HOOK-UP:

Using an additional good pair.



1-7. STRAP CONNECTION

A strap, or tie, must be installed between the fault conductor and the good pair at the far end of the cable section to be tested. Use the 9006 Conductor Strap, make a direct twisted connection or use "B" connectors. If wire is used, select 19 gauge copper, make it as short as possible and make a good connection.

Do not use tinsel transfer clip leads when making the strap connection. Some tinsel transfer clip leads are electrically equivalent to 600 feet of 19 gauge copper. A positive strap connection is very IMPORTANT.

1-8. LOOPMETER

Once the fault conductor and good pair have been isolated and connected in accordance with the appropriate hook-up diagram, the continuity of the conductor loop and strap can be tested with the loopmeter.

A series loop and strap resistance of less than 1500 ohms indicates GOOD. A resistance from 1500 ohms to 50,000 ohms indicates as HIGH RESISTANCE and from 50,000 ohms to infinity as OPEN.

1-9. USING THE LOOPMETER

Set the measurement switch to LOOPMETER and the loopmeter switch to GOOD PAIR. A GOOD indication means that the good pair has continuity and is strapped at the far end. A HIGH RESISTANCE indication means the loop resistance is higher than allowable for a normal telephone circuit.

When using a single pair hook-up, without a good pair, the good pair will indicate OPEN.

Set the loopmeter switch to GOOD TO FAULT. A GOOD indication means the good conductor and the fault conductor have continuity and are correctly strapped at the far end. This completes the hook-up test.

1-10. CONDUCTOR GAUGE

Set the GAUGE switch to the gauge of the fault conductor being tested. For multiple gauge combinations refer to the special applications section of this manual.

1-11. CONDUCTOR TEMPERATURE

Set the TEMPERATURE control to the approximate temperature of the fault conductor being tested. The temperature for underground and buried cable may vary from 30° to 80°F. A typical temperature is 55°F depending upon the depth, the geographic location and the season of the year. A more accurate temperature can be obtained by measuring the temperature of water running from an underground pipe. If a precise temperature is desired, refer to the THERMO-CALIBRATOR in the accessory section of this manual.

The temperature of aerial cable will be close to the temperature of the air, depending upon the time of day and exposure to the sun and may be as high as 120°F in direct sunlight in the summer.

1-12. DISTANCE TO STRAP MEASUREMENT

The DISTANCE TO STRAP measurement serves as a check on conductor gauge and cable routing.

Set the measurement switch to DISTANCE TO STRAP and rotate the digital dial to obtain a null on the meter. Set the MULTIPLY BY switch as required in order to obtain a null.

For multiple gauge combinations refer to the special applications section of this manual.

1-13. READING THE DISTANCE DIAL

With the MULTIPLY BY switch set to 1, the three digits on the digital dial read directly in feet. A reading of 023 indicates 23 feet and 123 indicates 123 feet.

Placing the MULTIPLY BY switch in the 10 position multiplies the distance reading by 10. A reading of 123 now indicates 1230 feet.

The MULTIPLY BY switch selects three distance ranges as follows: 0 to 1000 feet, 0 to 10,000 feet and 0 to 100,000 feet.

1-14. DOWN-RANGE FOR ACCURACY

In the event the first number on the digital dial is 0 and the MULTIPLY BY switch is set to 10 or 100, the MULTIPLY BY switch may be down-ranged for added readability and increased accuracy.

If the total conductor length is longer than the limit of the circuitry within the instrument, the OVER-RANGE light will flash indicating that a reading cannot be obtained with the MULTIPLY BY switch in this position. The MULTIPLY BY switch must be set to a longer range.

1-15. THE OVER-RANGE LIGHT

The OVER-RANGE light will flash whenever the total length of conductor between the red and white test clips exceeds the limit of the circuitry within the instrument. The flashing light indicates a valid null cannot be obtained. Usually the solution is to set the MULTIPLY BY switch to a longer range.

If the instrument or far-end-strap becomes disconnected, the light will also flash.

If the OVER-RANGE light continues to flash, even when the red and white test clips are test connected together, then the internal protection fuse may be open. Refer to FUSE in the maintenance section of this manual.

1-16. SERIES FAULT TEST

A test for a series resistance fault (partial open) in the fault conductor can be performed when using the separate good pair hook-up and the good pair is the same length and gauge as the fault conductor.

To test for a series fault, measure the DISTANCE TO STRAP and record this distance. Then disconnect the yellow test clip and measure the DISTANCE TO STRAP again. If the first distance measurement was longer than the second distance measurement by more than 5%, then the fault conductor has a series fault and should not be used for test.

If the first measurement was shorter, the unbal-

ance was due to the good conductor and will not affect the measurements.

1-17. NULL

Set the measurement switch to the NULL position and adjust NULL 1 control for a null indication on the meter. With "PRESS FOR NULL 2" button held down, adjust NULL 2 control to move meter needle away from null, then reset needle back on null for final adjustment. If meter needle cannot be set away from null before final adjustment, the fault may have dried out and should be rechecked using the FAULTMETER.

The NULL 2 control should not be moved after its final setting as it would affect the DISTANCE TO FAULT and STRAP TO FAULT measurements. If the NULL 2 control is disturbed, it may be set again without repeating previous measurements.

A swinging meter pointer during the null procedure may indicate more than one fault on the conductor under test. Placing the MULTIPLY BY switch in the X100 position during the null process will dampen the meter action.

1-18. FAULT MEASUREMENT

Set the measurement switch to DISTANCE TO FAULT and rotate the digital dial for a null on the meter. The reading on the digital dial multiplied by the MULTIPLY BY switch is the distance from the test-set to the fault in feet and should be recorded.

Set the measurement switch to STRAP TO FAULT and adjust the digital dial in the same manner as before. This reading is the distance from the far-end-strap back to the fault and should also be recorded.

The instrument may be down-ranged for improved readability and greater accuracy if the first digit on the digital dial is 0.

1-19. LOOP LENGTH MEASUREMENT

With the measurement switch set to LOOP LENGTH, the total electrical length of conductors between the white and red test clip is measured.

The LOOP LENGTH measurement can also be used to determine the equivalent electrical length of load coils and special test cords for the actual gauge of cable being tested.

1-20. BATTERY TEST

The test cable must be plugged into the instrument to test the batteries. Set the measurement switch to BATTERY TEST 1 and read the condition of the 4.5-volt batteries on the meter. Set to BATTERY TEST 2 to test the 9-volt batteries and to BATTERY TEST 3 to test the 45-volt battery.

All batteries are tested under full operating load and the instrument will still operate properly when the batteries test slightly into the replace zone. The batteries will provide more than 500 hours of operation.

For additional information, refer to BATTERY REPLACEMENT in the maintenance section of this manual.

1-21. OPERATING HINTS

A Determine if there are any load coils, bridge taps or conductor gauge changes between the test-set and the far-end-strap. If so, refer to the special applications section of this manual.

B When a sharp Null 2 cannot be obtained, verify that the 710A is properly connected in accordance with the instructions listed under paragraph 1-6. Be certain that the circuits are complete and that the black clip is connected to ground (for a ground or battery cross) or to the second conductor of the fault for ungrounded type faults.

C With a separate good pair hook-up, the DISTANCE TO STRAP measures the length of the conductor connected to the red clip. The red, yellow and white clips may be interchanged if it is desired to measure the length of the other conductors individually.

When using a single pair hook-up, the DISTANCE TO STRAP measures the length of the conductor connected to the red clip plus the length of the conductor connected to the white clip divided by 2.

D The length and gauge of the good-pair does not affect the distance measurements, however, the LOOP LENGTH will include the electrical length of one conductor of the good pair.

E The most favorable fault location, when using a single pair hook-up, is when the fault is near the test-set end rather than the far-end. With a separate good pair hook-up there is no difference.

F The good conductor for a single pair hook-up should test between the null line and the first O in GOOD on the FAULTMETER before it is connected at the far-end.

G A good strap connection is very IMPORTANT. The length of wire used to strap the fault conductor to the good pair is included in all distance measurements.

SECTION II ACCESSORIES

2-1. SELF-TEST TEST CABLE (Part number 9003)

The test cable furnished with the Dynatel 710A test set has a test fault built into the plug. Connecting the test clips to the terminals of the same color on top of the plug provides a means for checking the complete operation and calibration of the test-set, test cable and extension cable. For test procedure refer to SELF-TEST in the maintenance section of this manual.

2-2. EXTENDED TEST CABLE (Part number 9005)

A 40′ extended test cable is available for aerial access and other remote applications. This cable functions in the same manner as the standard 9003 cable except the 9005 cable does not incorporate the self test feature.

No allowance is necessary for the added test cable length and all distance measurements should be taken from the test clips.

2-3. EXTENSION CABLE (Part number 9002)

An extension cable is available for use with the 710A test-set. The extension cable is 33′ long and may be used at any time to extend the length of the test cable or thermo-calibrator.

All tests may be performed using the extension cable without correction or allowance since all distance measurements are made from the test clips on the test cable. Several extension cables may be used in series if a longer reach is required.

2-4. THERMO-CALIBRATOR (Part number 9004)

The purpose of the thermo-calibrator is to allow the 710A test-set to be set to the precise temperature at the location of the thermo-calibrator tip. The thermo-calibrator is available as an accessory for the 710A and is furnished with a 15′ cable.

Plug the thermo-calibrator into the test cable socket and set the controls as follows:

GAUGE:	26 gauge
FEET DIAL:	1000 feet (000 full clockwise)
MULTIPLY BY:	1
MEASUREMENT:	LOOP LENGTH

Adjust the temperature dial for a null. The instrument is now set to the exact temperature of the thermo-calibrator. The temperature may be read from the temperature dial of the 710A.

2-5. RESISTANCE FAULT SIMULATOR (Part No. 1005)

The 1005 Resistance Fault Simulator is a training device used to simulate and identify various types of faults that occur in telephone cable pairs. The basic simulator consists of two pairs of copper conductors (ring-tip, ring-tip) that approximate any four cable gauges. Resistors with pigtails and alligator clips are placed at marked intervals on the device to accurately simulate shorts, crosses and grounds under actual field conditions.

2-6. CONDUCTOR STRAP (Part No. 9006)

The 9006 Conductor Strap has been designed to simplify the strapping procedure (tie) and when used with the Dynatel 710A in the separate good pair hook-up described in Paragraph 1-6 B. will eliminate resistance errors.

SECTION III MAINTENANCE

3-1. SELF-TEST

A complete test of the instrument and test cable may be performed by connecting the test clips to the terminals of the same color on top of the test cable plug. The operation of the instrument is exactly the same as when connected to a telephone cable. The extension cable may also be connected for check-out.

The FAULTMETER should indicate a FAULT. Removing the red test clip should cause the meter to return to GOOD.

The LOOPMETER should indicate GOOD. Removing the white test clip should cause the meter to indicate OPEN. The GOOD zone of the faultmeter and loopmeter actually extend to the null line.

Any of the following distance measurements may be checked:

Gauge	Temp.	Distance To Strap	Distance To Fault	Strap To Fault	Loop Length
26 ga.	70°F	1000′ ± 10′	100′	900′	2,000′
24 ga.	70°F	1606′ ± 16′	161′	1445′	3,212′
22 ga.	70°F	2574′ ± 26′	257′	2317′	5,148′
19 ga.	70°F	5177′ ± 52′	518′	4659′	10,350′

The accuracy of the test fault is ±0.1% for the DISTANCE TO STRAP and LOOP LENGTH measurements which is used for all calibration. The accuracy of the test fault for the DISTANCE TO FAULT and STRAP TO FAULT measurements is ±2% and is used as an operational check rather than calibration.

The accuracy of the 710A test-set is ±1% of reading ±1 digit for all distance measurements.

3-2. ADJUSTMENTS

Calibration of the Dynatel 710A in the field should not be necessary.

METER ZERO: With the instrument OFF, the meter should indicate exactly null. The meter pointer adjustment is located at the left edge of the meter face.

3-3. BATTERY REPLACEMENT

The batteries will provide more than 500 hours of operation or six months to one year of service. All of the batteries will reach the replacement point at about the same time so it is advisable to replace the complete set of batteries at one time.

If one battery indicates REPLACE and the other batteries indicate high into the GOOD zone, then one battery may be defective.

BATTERY CROSS REFERENCE CHART

Quantity	Voltage	Neda	Eveready	Burgess	Ray-O-Vac
2 each	4.5V	3	736	F3	A3
2 each	9 V	1602	246	2N6	1602
1 each	45 V	213	415	U30	213

The cable in the battery compartment of the 710A uses a machine screw for the contact of the 4.5-volt batteries. Terminal type 4.5-volt batteries, such as KS-6570, may be connected by removing the machine screws and connecting the #8 lugs directly.

3-4. FUSE

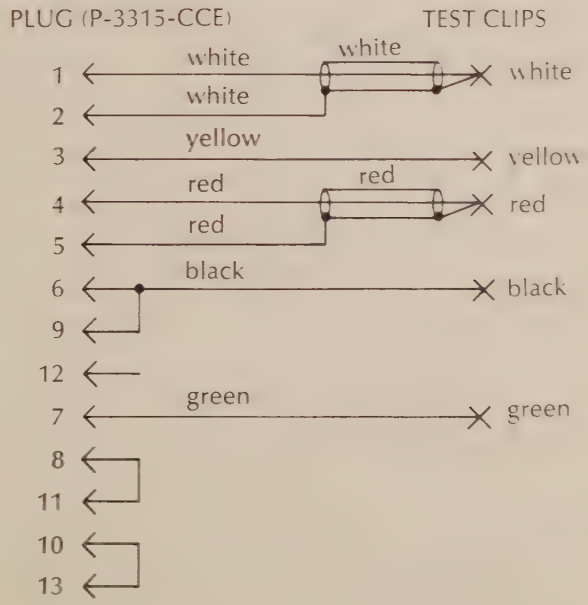
A fuse protects the instrument from damage as a result of accidental connection to a power line. The instrument will not be damaged when connected to voltages up to 350 volts DC and up to 250 volts AC.

The fuse will open if the current exceeds 1 ampere. This fuse is accessible from the battery compartment near the battery cable socket.

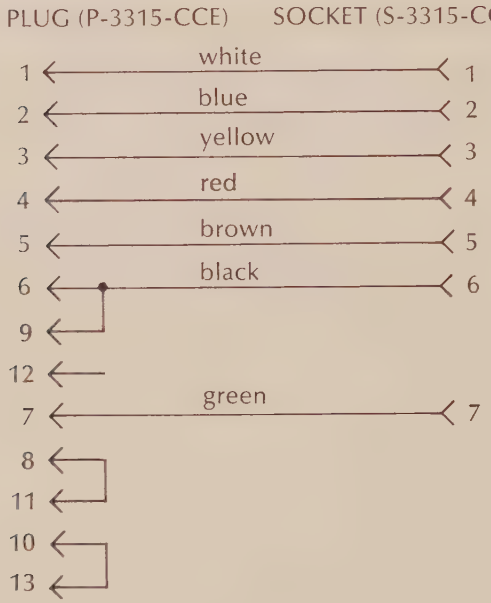
To test the fuse, set the measurement switch to DISTANCE TO STRAP and note the OVER-RANGE light flashing. Now connect the red and white test clips together and the light should stop flashing. If the light continues to flash, then the fuse should be replaced.

The fuse is a standard 3AG type 1 ampere fuse.

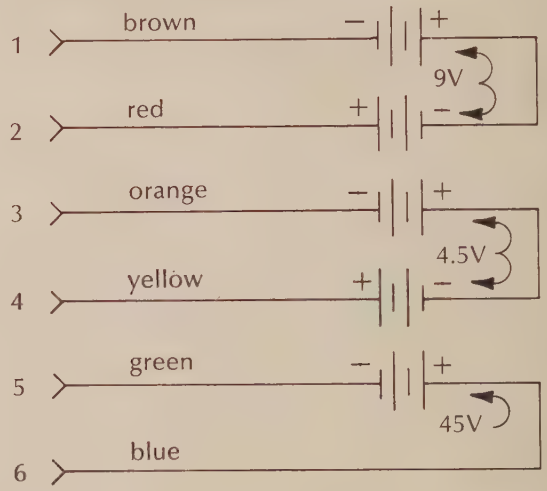
3-5. TEST CABLE DIAGRAM



3-6. EXTENSION CABLE DIAGRAM



3-7. BATTERY CABLE DIAGRAM



SECTION IV SPECIAL APPLICATIONS

4-1. B SERVICE AND D UNDERGROUND WIRE

B service wire contains iron and has electrical characteristics similar to 24 gauge copper. When testing "B" service wire, set GAUGE switch to 24 and the TEMPERATURE control to a temperature 26°F lower than the actual conductor temperature. For D underground wire, set GAUGE SWITCH to 19 and temperature control 15°F lower than actual conductor temperature. Type C rural wire can be tested as 19 gauge.

4-2. BRIDGE TAPS

When a bridge tap is located between the test-set and the strap, it is necessary to determine whether the fault is in the main section or in the bridge tap section. A fault that is located anywhere in the bridge tap section will measure to the point where the bridge tap is spliced into the main section.

To determine whether the fault is in the splice or the bridge tap section, disconnect the strap from the main section and connect a strap at an access point in the bridge tap section. The fault is now measured in the main section to the splice and then in the bridge tap section to the strap. If the fault still measures to the splice, then the fault is in the splice.

4-3. GOOD PAIR IN SEPARATE CABLE

The good pair does not have to be in the same cable as the fault pair, and does not have to be of the same gauge or the same length as the fault pair.

When testing short cable sections or buried drop, it is often faster to use a separate good pair such as "B" service wire or JKT wire. "B" service wire is very convenient because its foot markers can be used to measure the actual distance on the surface. When a reel of several hundred feet of wire has both ends available for connection, this wire need not be cut. Just roll off required amount of wire to complete the test, then roll back for reuse. Since only one pair is required for test, the other pair may be used as a talk pair.

The single pair hook-up cannot be used when the good conductor is a different length or gauge. The LOOP LENGTH measurement will include the length and gauge of one of the good pair and should not be used when a separate drop is connected.

4-4. ELECTRICAL MAPPING

Since a fault anywhere in a bridge tap section will measure to the point where the bridge tap is spliced into the main cable, this allows a convenient way to electrically map the cable at the time of installation.

Using the standard single pair hook-up, measure the DISTANCE TO STRAP and record for future use. Without changing the strap, ground the fault conductor anywhere along a bridge tap and measure the DISTANCE TO FAULT in the usual manner. This is the distance from the test-set to the splice where the bridge tap starts.

If this information is included in the records, then a fault that occurs in that cable section later can be located in feet from one of the original splice check points.

4-5. LOAD COILS

When a load coil is located in the cable section under test, measure the DISTANCE TO FAULT in the usual manner. If the DISTANCE TO FAULT is less than the distance to the load coil, then this is the correct distance. If the DISTANCE TO FAULT is longer than the distance to the load coil, then the STRAP TO FAULT measurement is correct.

The DISTANCE TO STRAP will measure longer than the true length by an amount equal to the electrical length of the load coil. The electrical length of load coils can be from 10 feet to over 1000 feet depending upon which coil is used and the conductor gauge.

To measure the electrical length of an individual load coil, connect it to the red and white clips, set the measurement switch to LOOP LENGTH, set the conductor GAUGE and TEMPERATURE controls and rotate the digital dial for a null. The electrical length may be read directly in feet from the digital dial and MULTIPLY BY switch.

If a fault is located between two identical sets of load coils, then the electrical length of the load coil may be subtracted from either the DISTANCE TO FAULT or STRAP TO FAULT distances to obtain a correct measurement.

With two load coils in a section of cable, the DISTANCE TO STRAP will measure longer than the

true length by an amount equal to the length of both load coils.

A chart for recording the electrical length of some common load coils is shown below:

Code	Electrical Length of Coil and Stub* (feet at 70°F.)			
	19 ga.	22 ga.	24 ga.	26 ga.
632	470	235	147	91
652	484	242	150	94
662	480	240	149	94

*Calculated for typical 5-foot stub.

4-6. EQUIVALENT LENGTH CALCULATIONS

For some measurement problems it is necessary to change an actual conductor length to an equivalent length of another gauge. Equivalent length calculations are not necessary because the 710A can compute the equivalent length and display the answer directly in feet on the digital dial.

Connect the 710A to a cable section, or the test fault, set the measurement switch to DISTANCE TO FAULT, and set the digital dial and MULTIPLY BY switch to the actual conductor length. Set the GAUGE switch to the gauge of the conductor and adjust the NULL 2 control for a null. Now set the gauge switch to the equivalent gauge and adjust the digital dial for a null. The equivalent length of the conductor is read directly from the digital dial.

4-7. EXTENSION LENGTH CALCULATIONS

Normally all measurements are made from the test clips on the test cable. When the 9002 extension cable is used, no calculations are necessary since all measurements are still made from the test clips.

If a length of conductor is connected between the test clips and the cable to be tested, then an allowance must be made for the length and gauge of this short section.

EXAMPLE: A 40-foot length of 26 gauge conductor is used to connect the test clips to a 22 gauge cable and the DISTANCE TO FAULT measures 500 feet of 22 gauge conductor.

Connect a strap at the location where the 26 gauge conductor connects to the 22 gauge cable and measure the DISTANCE TO STRAP with the GAUGE switch set to 22 gauge. The electrical length of this short section measures 101.5 feet and must be subtracted from the DISTANCE TO STRAP and DISTANCE TO FAULT measurements to obtain the true length.

In this case, subtract 101.5 feet from the 500 foot measurement to obtain a distance of 398.5 feet from the fault to the point where the 26 gauge conductor connects to the cable.

4-8. TEMPERATURE CONSIDERATIONS

Bridge type instruments measure the resistance of the conductors to determine their length. The resistance of copper changes when its temperature is changed, so temperature must be taken into account if an accurate length measurement is to be made. The resistance of copper changes by approximately 0.218% for each °F change in temperature. A few degrees may be insignificant, but a 25°F error in temperature will cause the length measurement to be in error by more than 5%. This phenomenon applies to all resistance bridge type instruments.

The TEMPERATURE control on the 710A should be set to the temperature of the fault conductor in the section being tested. If part of the cable is underground and part of the cable is aerial, then an estimate of each should be made and a temperature selected that represents an average condition for the section being tested. If the fault is found to be in the first portion of cable, then the TEMPERATURE control should be set to the temperature of that portion of cable for the fault distance measurements.

When the conductor temperature is below 0°F, set the TEMPERATURE control to 0°F for all distance measurements. The last DISTANCE TO FAULT and STRAP TO FAULT readings can be easily corrected for the exact temperature.

EXAMPLE: Correct a distance measurement for a conductor temperature of —40°F. First, record the distance reading with the TEMPERATURE control set to 0°F, then set the TEMPERATURE control to +40°F and subtract this new distance read-

ing from the 0°F reading. Now add this difference to the 0°F reading to obtain the —40°F distance.

4-9. TWO CONDUCTOR GAUGES

When two conductor gauges are used in a cable section, set the GAUGE switch to the gauge of the conductor at the test-set end and measure the DISTANCE TO FAULT in the normal manner. If the distance to fault is less than the distance where the gauge changes, then the DISTANCE TO FAULT measurement is correct.

If the distance to fault is longer than the length of the first gauge, then set the GAUGE switch to the gauge of conductor at the far-end strap and measure the STRAP-TO-FAULT distance. This is the correct distance from the strap to the fault without calculation.

If the cable has the same gauge at each end and has a section with a different gauge in the middle, refer to MULTI-GAUGE MEASUREMENTS.

4-10. MULTI-GAUGE MEASUREMENTS

When several conductor gauges are involved and the fault is located in the gauge of conductor that is connected to the test-set or the far-end-strap, then this may be measured directly. Refer to the preceding paragraph TWO CONDUCTOR GAUGES.

If the distance to the fault is longer than the length of the first gauge section, then set the GAUGE switch to the gauge of the second section and measure the DISTANCE TO FAULT again. Now subtract the equivalent length of the first gauge section and add the actual length of the first gauge section to obtain the true distance from the test-set to the fault.

EXAMPLE: In the diagram shown below, the DISTANCE TO FAULT measures 2200 feet of 24 gauge conductor. (Refer to paragraph 4-6.)

	1st		2nd		3rd		4th Section
TEST	1000′	X	2000′	X	3000′	X	4000′
SET	#26		#24		#22		#19

To obtain the equivalent length of the first section, set to DISTANCE TO FAULT, to 26 gauge, to 100 on the digital dial, to 10 on the MULTIPLY BY switch and adjust NULL 2 control for a null. Now set the GAUGE switch to 24 gauge and adjust the digital dial for a null. This is the 24 gauge equivalent length of 1000 feet of 26 gauge conductor. (ANSWER: 1606 feet.)

To obtain the actual distance to fault, subtract the 1606 feet from the measured distance of 2200 feet and add the 1000 feet of actual length. (ANSWER: 1594 feet from test-set to fault.)

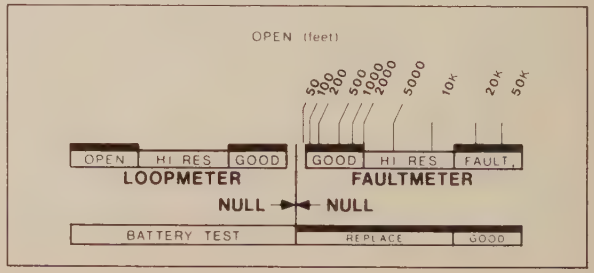
If the fault is in the third section, then use the same process except use the STRAP TO FAULT measurement instead of the DISTANCE TO FAULT.

4-11. BALLISTIC TESTS

Ballistic tests similar to the KS-8455 test-set or office voltmeter can be made with the 710A and lengths from 50 feet to over 20,000 feet can be read on one range.

To measure the length of a vacant conductor, set the measurement switch to FAULTMETER and connect the black clip to ground. First ground the conductor to be tested, then touch it to the red clip and note the maximum meter deflection. The faultmeter scale below shows the open length corresponding to a meter deflection. It is necessary to ground the conductor each time before repeating this test. Do not touch either the conductor or the metal of the red clip while performing this test.

When the conductors are longer than 1000 feet, the ballistic test can be performed by switching

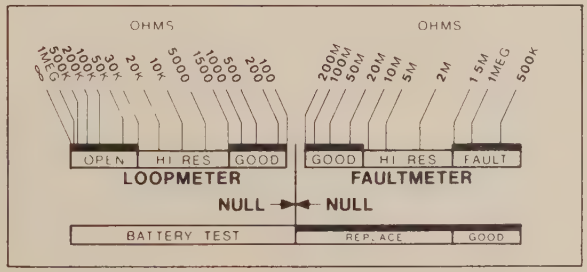


the measurement switch to OFF and then switching it back to FAULTMETER and noting the maximum deflection of the meter.

4-12. USING THE 710A AS AN OHMMETER

Both the FAULTMETER and the LOOPMETER can be used as an ohmmeter. The LOOPMETER is useful for resistance measurements from 100 ohms to 1 megohm, while the FAULTMETER is useful from less than 1 megohm to over 200 megohms. For high resistance measurements, set the measurement switch to FAULTMETER and use the red and black clips for test. The calibration is shown on the right.

For low resistance measurements, set the measurement switch to LOOPMETER, set the loopmeter switch to GOOD PAIR and use the white and yellow clips for test. The calibration is shown below.



SECTION V FACTORY SERVICE

Repair Policy

Returns

All items returned to Test and Measurement Systems/3M must be accompanied by a Material Return Authorization (MRA) number, which may be obtained by contacting the Test & Measurement Systems/3M Repair Department that services your particular product. After receiving an MRA number, the equipment should be shipped prepaid to:

Address	Applicable Products
Test & Measurement Systems/3M **Attn:** Repair Department 11705 Research Blvd. Austin, Texas 78759 512/258 1651 or 800/531 5308 TWX 910 874 2020	All APC™ and Dynatel® Products
Test & Measurement Systems/3M **Attn:** Repair Department 2860 Bankers Industrial Drive Atlanta, Georgia 30360 404/447 7145	All Dynatel Products and APC Facilities Products
Test & Measurement Systems/3M **Attn:** Repair Department 1941 Las Plumas Ave. San Jose, California 95133 408/926 3535	All Dynatel Products

NOTE: Both shipping carton and packing list must reference the MRA number. Enclosed with the equipment should be a statement giving the reason for return as well as the name, address and telephone number of the person to whom the unit is to be returned and billed.

Repair

Warranty on Repaired Equipment All repair of test and measurement instruments, except the APC 1301 and APC 1303 are warranted to be free from defects in material and workmanship for a period of ninety (90) days, commencing on the date of shipment to the buyer. APC 1301 and APC 1303 and all other Test & Measurement Systems/3M product repairs are warranted for 30 days. Test & Measurement Systems/3M's sole and exclusive obligations and liabilities under these warranties are and shall be limited to issuance of credit for or repair or replacement of any goods or parts which are proved to be other than as warranted; and Test & Measurement Systems/3M shall have sole discretion as to which of these remedies it shall provide. Test & Measurement Systems/3M shall not reimburse or make any allowance to buyer for any labor or freight charges incurred.

On-Site Repair On-site repair service is available for the APC 1301 only. Contact Test & Measurement Systems/3M in Austin, Texas for specific charges.

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Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising out of the use or the inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and the user assumes all risk and liability whatsoever in connection therewith.

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